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**GIS Applications in Weather Risk Management**

In investigating the use of GIS technology in weather risk management, it becomes apparent that the meteorological community, by and large, has not been on the absolute forefront in adapting GIS for day-to-day use.

One possible explanation for this is that atmospheric scientists have had a tendency to develop their own GIS application standards which have served the community well in terms of focusing on niches within the field, but have limited interaction with other research communities. It is becoming apparent that broader standards should be observed in the future to better facilitate multi-disciplinary studies involving weather and climate.

In spite of this, progress has been made in harnessing the potential of GIS as a tool in weather management, particularly over the last 5 to 7 years. Evidence of this can be found in the academic, public and private sectors and this will no doubt increase in the coming years.

Research into global climate change is one area of meteorology where GIS products are widely used. Comparison mapping of polar region ice and high-mountain snowfields over time provides evidence of climate change that may or may not be entirely related to human activity. Current and historical land cover data from various sources including orthophotos, older aerals, and LULC maps are used as a tool in determining large-scale changes in landcover, which in turn are often used as evidence that human disruption of the land is a major cause of global climate change.

GIS mapping has also been used to develop models for stormwater management. Parcel level data can be layered with orthophotos to perform localized drainage basin analysis as an aide in determining how much and what type of run-off can be expected across urban areas of all sizes. Similar data is also being used to model the likely debris field that would result from both wind as storm surge following a major coastal hurricane. Debris field projections can help to predict what the physical environment will look like immediately after damaging storms, which can help with identify areas of danger that may not be found in other ways and to aid in planning for post-storm clean-up operations.

In the public sector, The National Weather Service has developed the National Digital Forecast Database (NDFD), which make liberal use of GIS technology. Base maps use shapefiles such as DLG and TIGER95 state boundaries, county data, urban areas and city boundaries, and coastal and offshore marine zones for purposes of routine forecasting and for mapping watches and warnings, and also for verifying their accuracy. The watches and warnings themselves are also converted into shapefiles in the NDFD. Other spatial aspects mapped as shapefiles include fire weather zones, river basins and terrain features.

Some private-sector weather outfits are offering GIS “value-adds” to available government weather datasets. Examples include overlaying computer-generated
precipitation forecasts with drainage basins as an aid to forecasting river levels and the likelihood of flooding across an area or region. Products like these serve their vendors extremely well as they are able to create a suite of “canned” products that can be packaged any number of ways and sold to thousand of potential clients from Midwestern farmers to major transportation, energy and insurance interests. Little human input into the forecasting process is added once these systems have been developed, which makes them big money-makers for the company following the initial technical investment. Personal service formerly valued in the private weather industry has diminished in this process as companies don’t have or want the resources to provide customized consultations. Nonetheless, such a system is appealing to many users who appreciate easy to use, graphic-heavy, colorful depictions of what weather hazards might be approaching their location(s) of interest.

GIS education remains low on the priority list when it comes to training current and future atmospheric scientists. This will change as now-experimental publicly available products are refined and become more of a standard than the curiosity that they are now. The inevitable increase in government and private-sector use of GIS should create a demand for better GIS education at the undergraduate level over the next 10 years. Once people entering meteorology have more competence in GIS, it should become a staple application in the field.

**Annotated Bibliography**


Kucera et al. relate the results of a study to determine whether GIS technology can be used to help casual Doppler Radar Image users to interpret images that have problems with “ground clutter” and radar beam blockages due to terrain. Doppler radar has performed well in areas of rugged terrain but difficulties remain with some radar images in the Rockies, the West Coast and along the Appalachian. In this study, GIS-based software was developed and tested in Guam to determine how well it could resolve areas along the radar sweep with inaccurate (or no) data due to blockage by terrain. It was found that commonly available 30m DEM data worked well with the software, and that this GIS approach could provide useful and non-technical insight into the actual pattern of blocked areas within the sweep of Doppler radar.


This paper describes a study of precipitation patterns in Sconia, a roughly square peninsula that makes up the southernmost portion of Sweden. Precipitation data from a dense network of observing stations for meso-scale precipitation events over a 28-year period were analyzed by type of event, with type based largely on the track of low pressure centers and resultant wind vectors. The study used 500m DEMs for various physiography measures including station elevation, slope, aspect (from a south and
west origin) and distance to coast, with point data representing the actual observing stations.


In this paper, the authors discuss a method of determining the most appropriate spatial grid size to study the density of lightning strikes across an area based strictly on median location accuracy of lightning strike data. Five grids of different sizes were tested, using a UTM zone 13 projection at 38 degrees latitude. Randomly generated strikes were buffered in GIS for mean location accuracy, and the number of randomly generated strikes with buffers *entirely within* the grid was compared to the total number including those with buffers touching the grid to determine optimum grid size for lightning strike analysis. Not surprisingly, the largest grid studied (2306 sq. km or roughly 900 sq. mi.) led to greatest mean accuracy of strikes. In reality, a study area this size may be fine for regional scale lightning strike analysis, but a little large for local studies in areas like the Florida Peninsula.


Shepard et el. reference a study to determine the effects of the Urban Heat Island (UHI) effect on precipitation in areas around and downwind of major metropolitan areas. UHI has been an accepted concept in terms of microscale temperature differences between urban and nearby rural areas since the mid-1800s, but the study of other weather parameters in this context is much more recent. Here, researchers combined LULC, roads, drainage network and elevation data to find optimized siting locations for rain gauges and compared these regions to a spatially determined grid in an attempt to appropriately place rain gauges for the UHI study.


The article describes the proceedings of a workshop at the National Center for Atmospheric Research (NCAR) discussing uses and limitations of GIS in atmospheric research and data sharing. It is widely thought that GIS technology can make complex weather and climate data more accessible and user-friendly outside of the meteorological community. There is an acknowledgement that this community tends to develop their own standards for analyzing data, limiting interaction with other geo and social sciences. Concluding recommendations include the need to standardize these methods and to better educate the meteorological community in the concepts and use of GIS.

The author addresses a perception among the meteorological community the GIS is largely limited to mapping, while stating that mapping by GIS is indeed a very effective tool in showing how things relate spatially for purposes of climate research. The article illustrates three other GIS applications to weather and climate research; weather intelligence, essentially querying to extract elements of a large dataset for comparison purposes, storm damage analysis using multispectral satellite imagery, and geographic analysis of flash flooding. The latter was performed by layering elevation/slope, LULC and soil data with radar precipitation estimates to determine physiographic factors to flash flooding. This type of flash flood study model may be particularly useful in dry regions prone to brief downpours, such as the American Southwest.

**Additional References**


